

**Tunnel Detection Mission JT2727-02  
Final Report**

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Submitted to

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**KANSAS GEOLOGICAL SURVEY  
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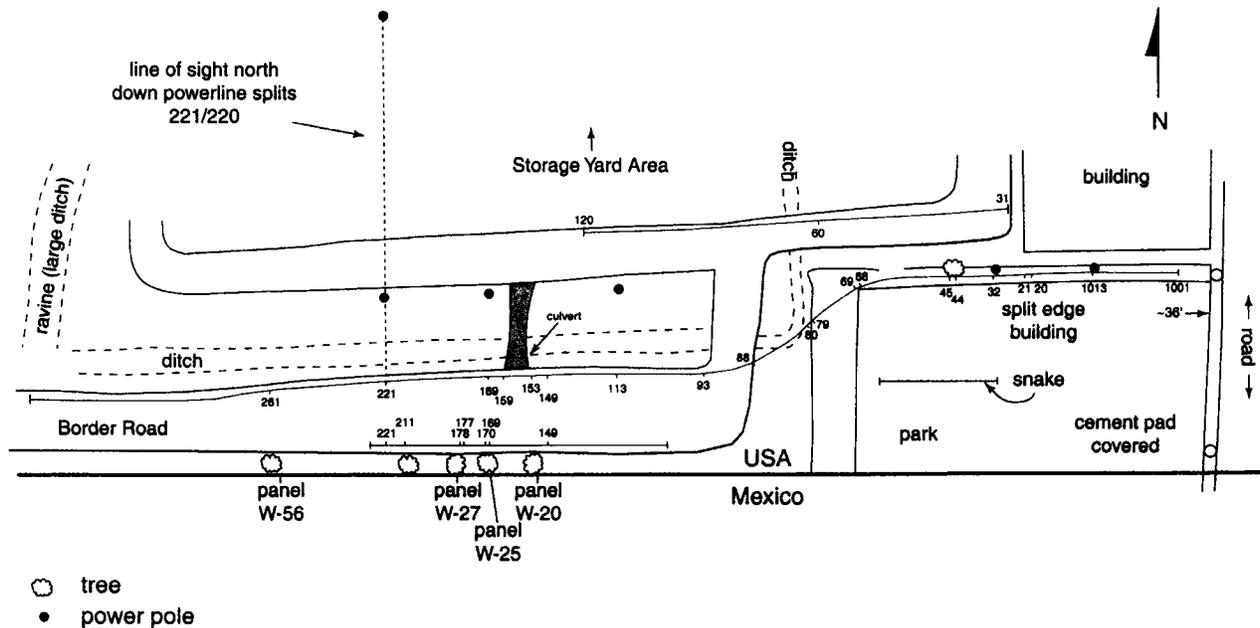
# TUNNEL DETECTION MISSION JT2727-02 FINAL REPORT

19 FEB 2002

Submitted by Richard D. Miller  
Kansas Geological Survey

## Executive Summary

During the period 15-17 January 2002, the USAE Waterways Experiment Station (WES) conducted a tunnel detection mission (JT2727-02) in support of the Drug Enforcement Administration (DEA), San Diego, CA. One scientist from WES, Mr. Robert Ballard, and two contract scientists, Richard Miller and Dr. Jianghai Xia from the Kansas Geological Survey, a research division of the University of Kansas, participated in the exercise. The objective of the mission was to demonstrate feasibility of new surface wave imaging technology for locating anomalous features along the border between the USA and Mexico near Tecate, CA. Prior to the Tecate investigation, anomaly signatures were studied at Otay Mesa, CA, to assist with anomaly classifications. During the two-day study at Tecate three unique profiles were acquired (Figure 1, station spacing 4 ft, the profile east of the border crossing not pictured).



Anomalies were interpreted in the field near stations 50, 70, 169, and 223 along the profile west of the border crossing, and at station 28 on the profile east of the border crossing. This information was provided on-site to all participating agencies with confidence ratings, error ranges, and estimated depths to anomalies. Enhanced study of the anomalies including line stepouts (moving the survey transect 20 to 30 ft, yet still parallel to the border fence and using consistent station identification numbers) and infield digital processing provided a continuous information stream between all cooperating groups. After preliminary processing at the Kansas Geological Survey's processing facility a drilling program was proposed that was designed to encounter and classify the anomalies interpreted on the seismic data (Appendix A).

Anomalies with lenticular geometries and point source type re-radiation patterns were detected, making the mission as designed a success (i.e., anomalies were located beneath the border road). The follow-up drilling program was not successful in uniquely identifying the source of the anomalies detected by the seismic technique and therefore the anomalies could not be classified. Confidence is high that the target anomalies were detected; however, confidence is low in the accuracy delineating the location of the anomalies with the preliminary data analysis techniques used. The current research result (post-drilling) suggests the station with the highest probability of encountering a confirmable anomaly was not sampled during the drilling program (167-169). All anomaly locations identified in the field and those selected based on preliminary off-site processing were fully documented. Further, baseline data acquired during this study can be used to locate areas that experience changes that might be representative of anomaly growth. No safety violations or accidents occurred. All safety procedures were followed in accordance with the KGS site safety plan.

### **Mission chronology:**

13 January: One civilian scientist, two technicians, and three graduate students departed permanent duty stations on the campus of the University of Kansas via heavy field trucks.

14 January: Two civilian scientists departed permanent duty stations, one from the campus of the University of Kansas, the other from US Army Corps of Engineers WES in Vicksburg, MS, via commercial air carrier, arriving at temporary lodging facilities in the San Diego area. One civilian scientist, two technicians, and three graduate students arrived via heavy field trucks at temporary lodging facilities in the San Diego area.

15 January: Met with JTF-6 representative, Lt. Col. Jeffery Swisher, at 0900 hrs for initial planning conference (IPC) and legal briefing conducted at DEA headquarters building in San Diego, CA. Following the IPC and legal briefing, a mission brief was conducted to coordinate the week's events with DEA lead investigators (Jake ?, et al). A brief reconnaissance mission to Otay Mesa, CA, which included seismic tool calibration, was completed by 1800 hrs.

16 January: Representatives from all groups involved with this mission met behind the US Customs Office at around 0900 hrs. Site reconnaissance was followed by line deployment and the east-to-west recording of data along the west (west of the crossing) border fence line. Processing was ongoing during acquisition and then through the evening hours.

17 January: All groups involved with the mission met behind the US Customs station at around 0700 hrs. Follow-up surveys were conducted along portions of the west border fence transect until sometime around 1400 hrs, when the emphasis was shifted to an area of the border road east of the border crossing. A main profile, including forward and reverse profiles, were acquired with some focused recording in a suspect area. Preliminary results and recommendations were passed along to DEA representatives at around 1800 hrs prior to leaving the field processing site behind the US Customs station.

18 January: Two civilian scientists departed San Diego and returned to their permanent duty stations, one to the campus of the University of Kansas, the other to the US Army Corps of Engineers WES in Vicksburg, MS, via commercial air carrier. One civilian scientist, two technicians, and three graduate students departed San Diego and returned to their permanent duty stations on the campus of the University of Kansas via heavy field trucks.

19 January: One civilian scientist, two technicians, and three graduate students arrived at their permanent duty stations on the campus of the University of Kansas via heavy field trucks.

## **Discussion**

As requested by both military and DEA personnel, this report will avoid detailed scientific discussion.

## **Lessons Learned / Problems**

More time needs to be allotted for on-site evaluation and associated program development unique to the geologic setting being evaluated. Multiple runs with tuned parameters need to be made along the target area to provide for extraction of consistent characteristics. Borehole confirmation relying on bit pressure is very subjective and might not provide the definitive ground truth refuting the presence of voids as interpreted from surface seismic data. A geologist, on-site to retrieve sediment samples and to monitor changes in material would have dramatically improved the value of the boreholes for calibrating the seismic imaging at this site.

## **Conclusions / Recommendations**

It was concluded that anomalies in the upper 60 to 80 ft were detected using surface wave energy in the Tecate, CA, area. Delineation of the exact location of these anomalies requires ground truth or definitive correlation to known features. The Otay Mesa, CA, anomaly allowed generalized calibration, but with the differences in geology and sediments between the Otay Mesa and Tecate sites, unique, site-independent classification of interpreted anomalies was not possible.

Ongoing evaluations of the data sets will provide more conclusive results with anomaly locations refined based on optimal data characteristics. Evaluations by KGS scientists after leaving the field focused on shadowing effects of anomalies, while in field analysis targeted anomaly scattering phenomena. Both are legitimate approaches, but, based on drilling and ongoing analysis, anomaly scattering appears to have the greatest potential for providing anomaly delineation with location accuracy error sufficiently constrained and small enough to allow drill confirmation.

Once data analysis is concluded, a revised anomaly map will be produced. This anomaly map will incorporate all data and all data analysis techniques and will be consistent with the drilling program already completed at the Tecate, CA, site. It would be helpful to obtain a location map of all boreholes relative to station numbers to allow improved confidence in any interpretations based on future processing.

## Appendix A

Sent to Robert Ballard 1/30/02:

After much pondering and looking at the data we have come to the following conclusions:

- 1) Several seismic anomalies exist at the Tecate site that are similar in character to the known tunnel location at the Otay site.
- 2) We are more confident an anomaly exists at the Tecate site from the same type of source encountered at the Otay site than we are in our ability to locate it precisely for drill confirmation.
- 3) Two types of anomaly characteristics seem to be representative of the type of anomaly encountered at the Otay site: back scatter and attenuation/reverberations.
- 4) From back scatter alone we would pick the following drilling pattern: start with station 185, if no anomaly is encountered then 184, next 186, then 183, followed by 187, and so on until you reach 180 and 189; based on comparisons with Otay it is most likely the anomaly is between 185 and 186 (figure).
- 5) Next looking at the apex of the scatter you should then go to station 176 and repeat the pattern with 175 being the second hole, 177 being the third hole, 174 the fourth and so on until you drill station 179 (figure). The combination of this pattern and the one defined under item (4) must encounter the anomaly--using the characteristics of the Otay site station 185 is our spot, I guess it is a matter of having faith that the characteristics of the anomalies are the same.
- 6) Another anomaly zone exists out at 237 to 231. This zone has the scatter characteristics but does not have the reverberation/attenuation signatures. Again we would suggest drilling from 237 to 231 on each station.
- 7) The least likely location to encounter an anomaly will be between 80 and 85. I am skeptical about this location due to the proximity of the drainage ditch, but it does have the scatters that are one of the two criteria.
- 8) With the most recent analysis, the station 50 anomaly identified in the field extends from 20 to almost 60, a zone that is much too wide for consideration at this time. It does exist, but we are thinking it is geologic due to its width, with less developed and lower amplitude scatter hyperbola.

From frequency alone we would anticipate the anomaly to be from around 25 ft to 30 ft based on 1/2 wavelength criteria, so drilling to at least 60 ft would definitely get it. If the choice is drilling less depth and more holes, we say more holes and drill them to 40 ft.

At this point we are concentrating our analysis on the reverse shots (i.e., west to east) to match character and try to get better location accuracy. I have included the drawing I made of the site in case Jake needs it. We will continue to work on refining our locations—we are confident an anomaly exists with characteristics consistent with the Otay tunnel (i.e., high confidence a tunnel was detected at Tecate), we have low confidence in our ability to delineate the exact location of the anomaly. However, the sharpness of the picture will improve with more and different processing.

One question that would be interesting to know the answer to is: How many holes are they willing to drill?

We would like to know when the drill is actually on site and drilling. That will provide us with a clear schedule for a last and final interpretation.

Apex of Scatter

Attenuation/Reverberation

Station #						
173	174	175	176	177	178	179
17	15	13	11	12	14	16

Station #									
180	181	182	183	184	185	186	187	188	189
10	8	6	4	2	1	3	5	7	9

Drill Hole Number

